AP 2622

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Philip Atkin	§	Group Art Unit:	2622
Serial No.: 10/038,569	§	Examiner:	Aggarwal, Yogesh K.
Filed: January 2, 2002	§		
For: Method of Obtaining an Image	§	Atty. Docket:	GJEL:0003/FLE MJB06834US

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37 C.F.R. 1.8

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September 21, 2007 — Toni Hill
Date — Toni Hill

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37

This Appeal Brief is being filed in furtherance to the Notice of Appeal mailed on July 18, 2007, and received by the Patent Office on July 23, 2007.

1. REAL PARTY IN INTEREST

The real party in interest is Synoptics Limited, the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 012446, frame 0787, and dated January 2, 2002.

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2. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellant's legal representative in this Appeal. Synoptics Limited will be directly affected by the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 1 and 3/1 are currently pending and under final rejection and, thus, are the subject of this Appeal.

4. STATUS OF AMENDMENTS

The present application is not subject to any pending amendments.

5. SUMMARY OF CLAIMED SUBJECT MATTER

This appeal addresses independent claim 1. Below, Appellant explains this claim by identifying specific embodiments in the specification. While these embodiments exemplify the appealed claim, they do not necessarily define its scope. Thus, this claim should not be construed as limited to the following embodiments by virtue of this explanation.

Independent claim 1 recites:

> A method of creating an image which includes the steps of:
>
> obtaining a substantially linear representation of the brightness of an image, the method comprising, for each of a set of pixels (x, y) in a two dimensional array, calculating an estimate of the true image intensity (i_{xy}) as a weighted average of n samples of the apparent image intensity ($v_{n,xy}$) as

$$\hat{i}_{xy} = \frac{\sum_n \left(w_{n,xy} \left(\frac{v_{n,xy} - C}{KT_n} \right) \right)}{\sum_n w_{n,xy}} = \frac{1}{K} \frac{\sum_n \left(w_{n,xy} \left(\frac{v_{n,xy} - C}{T_n} \right) \right)}{\sum_n w_{n,xy}}$$

where $v_{n,xy}$ is the apparent intensity measured, n is greater than or equal to 2, T_n is the exposure time, K is the gain of the system, C is an offset and $w_{n,xy}$ is a weighting factor which is defined to maximise the signal to noise ratio and discard insignificant, that is saturated or near zero, values;

thereafter saving each of the values i_{xy} together with other data representing the image; and

outputting the image to a display or to a printing device.

In the application, the subject matter of claim 1 is exemplified by a process performed by software executed by a computer 3. *See* application, paragraph 46; and FIG. 1. The process includes performing the following steps to obtain a substantially linear representation of the brightness of an image:

1) Initially, the process **acquires two or more images** of the same object. *See* application, paragraph 56. Each of the images is acquired with a different exposure time. So even if the camera 1 has a limited dynamic range, the images with a longer exposure time capture detail from darker areas of the object, and the images with a shorter exposure time capture detail from brighter areas of the object. *See id.* Consequently, the images as a group depict a wider range of light intensity than any one image in the group. *See id.* at paragraph 4. In this example, the number of images exemplifies the

referent quantity of the variable "n" in claim 1, so for two-input images, n equals 2.

2) Next, the exemplary process **combines the two or more input images into a single output image** that shows the full range of light intensity captured by all of the images. *See id.* at paragraph 56. That is, details from both the dark regions and the light regions are contained in the single output image. *See id.* at paragraph 2. The exemplary process combines the images pixel-by-pixel, so one pixel from each input image is combined to form a single pixel in the resulting image. *See id.* paragraph 12. Thus, in this example, if n equals 2, a pixel from one input image is combined with a pixel from the other input image to calculate the intensity of a single pixel in the output image. This process is repeated for each of the pixels in the output image. As explained below, the input pixels are combined according to an equation that produces a substantially linear representation of object brightness. *See id.* at paragraph 19. That is, the brightness of the representation is substantially proportional to the brightness of the object being imaged, so neither the darker areas nor the lighter areas of the object are saturated in the representation. *See id.*

In this embodiment, the parameters of the pixels in both the input images and output image exemplify the referent quantities of some of the variables in claim 1. The referent quantity of the variable "i" in claim 1 is exemplified by the intensity of a pixel in the output image, and the referent quantities of the subscript variables "x" and "y" that index the variable "i" are exemplified by pixel locations in the resulting image, e.g., the row and column addresses

of the pixel. *See id.* at paragraph 12. Similarly, the referent quantity of the variable "v" is exemplified by the pixel intensities in each of the two or more input images. The variable v is indexed by both the subscript variable "n," which in the present example refers to the number of input images, and the subscript variables x and y, referring in some instances to row and column locations. *See id.*

Examples of the other variables in the equation of claim one are also described in the application. "T_n," the exposure time for an input image, is discussed both in paragraph 4 and in paragraph 21, which describes considerations that may be relevant when selecting values for "T_n." Examples of the gain of the system, "K," are described in paragraphs 7, 13, 40, and 41 of the application. Examples of the offset, "C," are described in paragraphs 7, 13, 23-28, and 56 of the application, and an example of the weighting factor, "w," is described in paragraph 13. In this embodiment, the variable "w" is indexed both by the subscript variable "n," exemplified by an index number of the input pictures, and the subscript variables "x" and "y," exemplified by row and column locations of pixels in the input images.

The referent quantities of these variables are combined through the equation of claim 1. The combination produces a digital image whose values are related linearly (i.e. proportionally) to the intensity of light falling on the light sensor (e.g., the camera 1 in FIG. 1), even when there is a very wide range of such intensities. *See id.* at paragraph 19. The equation combines the series of images taken with different exposure times by both thresholding data in the input images to remove the effects of saturation and applying the appropriate weighing factor to each pixel of each input image. *See e.g., id.* at paragraphs 16-19.

Examples of the other steps of claim 1, saving and outputting, are described in paragraph 44: saving is exemplified by the act of placing the digital image 4 in the computer's memory, and outputting is exemplified by the act of displaying the digital image 4 on a monitor 5. *See id.* at paragraph 44; and FIG. 1.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The Examiner rejected claims 1 and 3 under 35 U.S.C. § 103 (a) as being obvious over U.S. Patent 5,828,793 (Mann) in view of U.S. Patent 4,590,582 (Umemura). The Examiner also rejected claim 2 for relying on claim 1 but indicated that it would be allowable if placed in independent form, and Appellant reserves the right to do so if necessary. Appellant respectfully urges the Board to reverse these rejections.

7. ARGUMENT

To reject the pending claims, the Examiner misapplied long-standing and binding legal precedents. Below, Appellant summarizes both the rejection and the relevant precedent and, then, explains why the rejection violates the relevant precedent.

The Rejection

In the Final Office Action, the Examiner rejected claims 1 and 3/1 as being obvious over Mann in view of Umemura, remarking:

> Mann discloses a method of creating an image with a still video camera (col. 11 lines 43-46, figure 8, element 202). Mann further teaches that the image is transferred to a computer to be stored on a main memory 210 represented as 212_1, 212_2, 213_3 etc. (col. 11 lines 46-54). Mann also teaches that the composite images [are] formed from a series of input images wherein every pixel of

the composite image is drawn from the corresponding pixel in each of the input source images according to a weighted average. The weighting is based on a certainty function associated with each source image pixel corresponding to an output pixel in the final composite image. The value of the relevant pixel parameter for a given final-image pixel (weighted average of n samples) is given by

$$\sum_n c_n P_n / \sum_n c_n$$

where c_n is the certainty function associated with the corresponding pixel of each source image n (col. 6 line 51-col 7 line 8). It is noted that P_n (pixel parameter) is dependent upon exposure time, brightness or luminance and the gain of the system. Mann teaches that the resulting pixel image represented by the expression above is saved in a target buffer 250 whose contents are shown on screen display 234 (col. 12 lines 32-49). The features such as gamma correction (other image data) are also stored in the target image data (col. 13 lines 4-8).

Mann fails to teach explicitly obtaining a substantially linear representation of the image by combining two images. However Umemura teach that when various parameters are used for one original image data, the image data filtered by the 3.times.3 filter 2 and stored in the memory 3 is read out for each such parameter. Then, the original image data and the filtered image data are subjected to linear combination by the adder device 5 in order to achieve high-speed processing (col. 8 lines 23-39, figure 9, also see col. 7 line 53-col. 8 line 23, figure 1).

Therefore taking the combined teachings of Mann and Umemura, it would be obvious to one skilled in the art at the time of the invention to have been motivated to have obtained a substantially linear representation of the image by summing two images in order to achieve high- speed processing as taught in Umemura (col. 8 lines 23-39).

[Claim 3/1]

Mann teaches that the different images are color so that the offset will be color dependent (col. 13 lines 21-30).

Final Office Action, pages 3 and 4.

As explained below, this rejection fails to satisfy the Examiner's burden to demonstrate that *all* of the elements are obvious in view of the prior art. Specifically, the rejection is flawed because the Examiner has not proved that one of ordinary skill in the art would find it obvious to obtain a substantially linear representation of the *brightness* of a scene.

Legal Precedent

The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). Even if, *ad arguendo*, the references *could* be combined or modified in the proposed manner, it does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *See In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d. 1430 (Fed. Cir. 1990). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the combination includes *all* of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the references. *Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985).

It is Not Obvious to Obtain a Substantially Linear Representation of the Brightness of a Scene by Combining Two or More Images

This rejection is flawed because neither cited reference teaches obtaining a <u>substantially linear representation of the brightness</u> of a scene by combining two or more images. Indeed, the Examiner has recognized that the primary reference, Mann, does not teach obtaining such a

representation. *See* Final Office Action, page 4. The rejection instead relies on Umemura for this feature, but as is explained below, Umemura does not teach or suggest obtaining a substantially linear representation of the brightness of a scene either.

Umemura teaches a technique that distorts image brightness to enhance edges. The edges are refined, according to Umemura, by spatially filtering an image—that is, changing pixel brightness based on neighboring pixels—and combining the filtered image with a version of the original image. *See* Umemura, col. 2, lines 49-66; and FIG. 1 (illustrating an adder device 6 that combines the original image, stored in OID memory 1, with the filtered image, stored in FID memory 3). The combination is depicted in FIG. 6 of Umemura and described in column 6, lines 43-52. As explained in this passage, the filtered image data is added to the original image data in the adder 76, after both sets of image data are multiplied by weighting coefficients in multiplier elements 65 and 66. *See id.* Thus, an original source image is combined with a filtered version of itself to produce an output image that exaggerates certain image features, such as edges.

Although Umemura refers to the combination operation as a "linear combination," it does not produce a substantially linear representation of image brightness. Umemura combines the original image with a filtered image that distorts image brightness. To produce the filtered image, Umemura combines pixels from different locations in the single, original source image. *See* Umemura, col. 1, lines 17-25. The filter is described as a 3x3 linear non-recursive type two-dimensional filter, and Umemura explains that it is effective "for noise removal, sharpness control, edge enhancement and the like." *See id.* Thus, Umemura teaches sharpening or blurring the original image through a spatial filter that changes pixel intensity according to adjacent pixel intensities. Consequently, the intensity of a pixel $i_{x,y}$ in the filtered image is not proportional to

image brightness at a location corresponding to x and y; it is a function of other pixels nearby. It follows that, regardless of whether the combination of the original image with the filtered image is a linear operation, the combination does not produce a substantially linear representation of image brightness, because the spatially-filtered image is, by definition and design, distorted.

Moreover, this inadequacy in the rejection is not cured by the combination of references. Combining the teaching of Mann and Umemura would not produce an image whose values were linearly related to the light intensity. In fact, the calculation step of Umemura would just blur or sharpen each of the individual source images.

Mann teaches how to calculate an output image, each of whose pixels are calculated by combining the corresponding pixels from each of a number of source images. As the Examiner has already accepted, Mann does not teach how to make each pixel's value proportional to the light intensity at the pixel location. Mann does not teach how to derive the weights so as to result in a linear relationship between light intensity and digital value. Mann simply combines a number of images taken at different exposures. Mann does not discuss altering the spatial characteristics of the image, which would be achieved by combining pixels taken from different locations.

As explained, Umemura teaches how to achieve a user-controlled modification of the spatial frequency characteristics of a single source image. Umemura does not discuss a process that combines a number of source images. The technique of Umemura combines pixels from different locations in the single source image.

To combine the teaching of the two documents is non-obvious. In the unlikely event of a skilled person considering combining the teachings from the two documents there are two ways in which this might be done:

1) The source images could be spatially filtered according to Umemura and then processed according to Mann. The spatial filtering, however, would destroy the relationship between light intensity and pixel value within each source image that is essential for Mann's algorithm. Further, the final result would be spatially filtered and therefore not reproduce faithfully the frequencies of the source images. Finally, it would not provide a result image in which each pixel's value is proportional to the light intensity at the pixel location.

2) The source images could be combined into a single image according to Mann and then spatially filtered according to Umemura. In this case each method would 'work' independently within its own terms of reference. However, it would not provide a result image in which each pixel's value is proportional to the light intensity at the pixel location.

Accordingly, it clear that is not obvious to combine the teaching from the two documents, and, even if the documents were combined, it is not possible to arrive at the result of the present invention.

As has been repeatedly explained to the Examiner, the present invention, like Mann's, combines only spatially corresponding pixels from each source image to calculate each pixel in

the result. To do otherwise (that is, to combine pixels from other locations) would destroy the information necessary to perform the calculation correctly. (For example, if a 3x3 spatial filter were used to combine neighbouring pixels and some of those pixels were 'invalid' because they were saturated, it would not be possible to determine whether such saturation had taken place). The present invention differs from Mann's, however, in that it teaches how to combine the pixels in order that each output pixel is directly proportional to the light intensity at the pixel location. The fact that Umemura teaches a method in which a result is formed by a weighted sum (otherwise referred to as a 'linear combination') of two other images - a step that must appear in just about every digital image processing operation ever designed - does not mean that it provides any teaching on how to achieve an output image whose pixels are directly proportional to light intensity.

After the Appellant alerted the Examiner to this missing feature, the Examiner responded by simply reiterating that Umemura teaches a linear operation and begging the question of whether the operation can succeed in producing an image that is linearly related to the pattern of light falling on the sensor. In the Final Office Action, the Examiner asserted:

> Applicant argues at pages 8 and 9 that the present invention differs from Mann and Umemura in that it teaches how to combine the pixels in order that each output pixel is directly proportional to the light intensity at the corresponding pixel location. To do otherwise (that is, to combine pixels from other locations) would destroy the information necessary to perform the calculation correctly.
>
> In response, the Examiner respectfully disagrees with the Applicants' assessment of the claims since the claims are written much broader than the Applicants' arguments. It appears that the Applicants brought [the] specification into the claims which are written much broader than what they should be.

> In fact, Umemura teach that when various parameters are used for one original image data, the image data filtered by the 3.times.3 filter 2 and stored in the memory 3 is read out for each such parameter. Then, the original image data and the filtered image data are subjected to linear combination by the adder device 5 in order to achieve high-speed processing (col. 8 lines 23-39, figure 9, also see col. 7 line 53-col. 8 line 23, figure 1) which reads on the claimed limitations "obtaining a substantially linear representation of the image by combining two images".
>
> Therefore, in response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., how to combine the pixels in order that each output pixel is directly proportional to the light intensity at the corresponding pixel location) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Final Office Action, pages 2 and 3.

The Examiner asserts that claim 1 is broader than the Appellant's previous arguments because Appellant argued that claim 1 recites obtaining a substantially linear representation of the brightness of a scene by combining corresponding pixel locations. The Examiner's assertion, however, is false. The claims include formulae where every pixel value explicitly contains the suffix xy to denote that the result at the two-dimensional coordinates (x,y) are derived only from pixel values with the same suffix and constants. Therefore, each pixel result is obtained without any influence of neighbouring pixels. If the formulae referred at all to neighboring pixels , the suffices would include terms like x+1,y or x, y-1; they do not.

Further, the Examiner's argument ignores the phrase "of the brightness of an image." Indeed, in the rejection, the Examiner omits the word "brightness," and none of the Office

Actions allege that the cited art produces a representation that is substantially linear with respect to the brightness of an image.

The Examiner still has not explained how the cited references teach "obtaining a substantially linear representation of the brightness of an image." As explained above, Umemura teaches spatially filtering an image and then combining the spatially-filtered image with the original image. Regardless of whether the combination operation is linear, it does not produce a substantially linear representation of scene brightness, because the input to the process has been subject to a non-linear operation: very bright and very dark pixels are distorted non-linearly by the camera due to its limited dynamic range.

Information lost in this non-linear operation cannot be restored by spatial filtering technique such as Umemura's; it can only be regained by combining two or more images that cover different parts of the total dynamic range of the scene. Indeed, the intended purpose of the system taught by Umemura is to enhance features, such as edges, in the image by spatially filtering the image and exaggerating these features; it cannot contribute to the requirement to 'undo' the camera's non-linear response (as the present invention does). *See* Umemura, col. 1, lines 39-52. In short, Umemura's pixels distort image brightness. The Examiner has not identified a reference that describes the claimed type of linear operation, and the present rejection fails to satisfy the Examiner's burden of proof.

For these reasons among others, Appellant respectfully requests withdrawal of the rejection under 35 U.S.C. § 103 and allowance of all pending claims.

Conclusion

In view of the above remarks, Appellant respectfully submits that the Examiner has no supportable position or evidence that claims 1-3 are obvious under Section 103. Accordingly, Appellant respectfully requests that the Board find claims 1-3 patentable over the art of record, withdraw all outstanding rejections, and allow claims 1-3.

In accordance with 37 C.F.R. § 1.136, Appellant requests that this and any future reply requiring an extension of time be treated according to the General Authorization For Extensions Of Time previously submitted.

The Commissioner is authorized to charge the requisite fee of $500.00, and any additional fees which may be required, to Deposit Account No. 06-1315, Order No. GJEL:0003 / FLE.

Respectfully submitted,

Date: September 21, 2007

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8. APPENDIX OF CLAIMS ON APPEAL

1. (Previously presented) A method of creating an image which includes the steps of:

obtaining a substantially linear representation of the brightness of an image, the method comprising, for each of a set of pixels (x, y) in a two dimensional array, calculating an estimate of the true image intensity (i_{xy}) as a weighted average of n samples of the apparent image intensity ($v_{n,xy}$) as

$$\hat{i}_{xy} = \frac{\sum_n \left(w_{n,xy} \left(\frac{v_{n,xy} - C}{KT_n} \right) \right)}{\sum_n w_{n,xy}} = \frac{1}{K} \frac{\sum_n \left(w_{n,xy} \left(\frac{v_{n,xy} - C}{T_n} \right) \right)}{\sum_n w_{n,xy}}$$

where $v_{n,xy}$ is the apparent intensity measured, n is greater than or equal to 2, T_n is the exposure time, K is the gain of the system, C is an offset and $w_{n,xy}$ is a weighting factor which is defined to maximise the signal to noise ratio and discard insignificant, that is saturated or near zero, values;

thereafter saving each of the values i_{xy} together with other data representing the image; and

outputting the image to a display or to a printing device.

2. (Original) A method according to claim 1, wherein a linear relationship is established between images recorded with different exposure times by the use of a perpendicular regression technique whereby each image is transformed to match the scale and offset of the first in the series and whereby the weighted average is calculated as:

$$\hat{i}_{xy} = \frac{\sum_n w_{n,xy}\left(\frac{v_{n,xy} - \sum_n b_n}{\prod_n a_n}\right)}{\sum_n w_{n,xy}}$$

where a_n and b_n are the gradient a and offset b measured between image n and image n 1 (a_1=1; b_1=0) when

$$w_{n,xy} = \begin{cases} \prod_n a_n & v_{\min} < v_{n,xy} < v_{\max} \\ 0 \quad \text{when} & v_{n,xy} \geq v_{\max} \\ 0 & v_{n,xy} \leq v_{\min} \end{cases}$$

3. (Original) A method according to claim 1 or claim 2, wherein the image is a coloured image and the offset is colour dependent.

9. EVIDENCE APPENDIX

None

10. RELATED PROCEEDINGS APPENDIX

None